Dynamics and stability of bistable planar fronts in multidimensional reaction-diffusion systems under nonlocalized perturbations

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Bistable planar fronts play a fundamental role across a wide range of applications as propagating or stationary transition layers between two stable homogeneous states. In multidimensional dissipative systems, such as reaction-diffusion models, these fronts are known to be asymptotically stable against localized perturbations under natural spectral assumptions. However, this localization requirement is not entirely satisfactory. Not only does it exclude initial perturbations corresponding to a spatial translation of the front, but it also prevents certain interesting dynamics of the perturbed front from being observed. In particular, the front interface may undergo persistent oscillations without ever settling to a steady translate, precluding asymptotic (orbital) stability. In this talk, I establish Lyapunov stability of bistable planar fronts in general multicomponent reaction-diffusion systems against fully nonlocalized perturbations. Such perturbations could previously be treated only for scalar equations via comparison principles. Moreover, I show that the leading-order dynamics of the front interface are governed by a viscous Hamilton–Jacobi equation. This effective description reveals that asymptotic stability can be recovered by imposing localization of perturbations in the transverse spatial directions. This is joint work with Joris van Winden (Delft University of Technology).